PB-217 059

MUNICIPAL WASTE REPORT, METROPOLITAN DENVER AREA, SOUTH PLATTE RIVER BASIN

Federal Water Pollution Control
Administration
Denver, Colorado

December 1965

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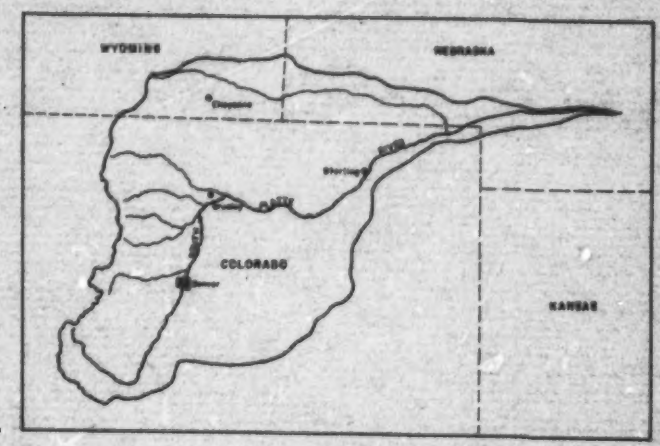
MUNICIPAL WASTE REPORT METROPOLITAN DENVER AREA SOUTH PLATTE RIVER BASIN



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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
DIVISION OF WATER SUPPLY AND POLLUTION CONTROL
SOUTH PLATTE RIVER BASIN PROJECT
DENVER, COLORADO

DECEMBER 1965

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ERRATA SHEET

Municipal Waste Report - South Platte River (December 1965)

Pg. v - Last line of Conclusion No. 2 - "summer of 1965" should be changed to "summer of 1966".

Pg. viii - Last line of Recommendation No. 5. - "January 1, 1966" should be changed to "January 1, 1967".

Pg. 24 - Second line of paragraph two - "currently undergoing renovation" should read "renovated".

Pg. 26 - Twelfth line - "1965" should read "1966".

Pg. 26 - Last paragraph - Plants presently affiliated with MDSDD#1 should include Thornton.

Pg. 28 - "Plants not presently Members of MDSDD#1:" - Thornton should be deleted from this category and added to "Member Plants of MDSDD#1". All remarks pertaining to Thornton remain the same as shown.

Pg. 29 - Last entry in "Suggested Abatement Schedule" column should read "Jan. 1967".

Pg. 30 - First entry in "Suggested Abatement Schedule" column should read "Jan. 1967".

MUNICIPAL WASTE REPORT
METROPOLITAN DENVER AREA
SOUTH PLATTE RIVER BASIN

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control
South Platte River Basin Project
Denver, Colorado

December 1965

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SOUTH PLATTE RIVER BASIN PROJECT
U. S. Public Health Service

Background and Objectives

On July 18, 1963 the Governor of Colorado requested the Secretary of Health, Education, and Welfare to assist the State in determining sources of pollution and quality of waters of the South Platte River Basin within the State of Colorado.

The First Session of the Conference in the matter of Pollution of the South Platte River Basin was held in Denver, Colorado on October 29, 1963 under the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 466g). It was established at this Conference that a study would be undertaken by facilities of the U. S. Public Health Service. Findings and recommendations from this study would lead to a program of pollution abatement to be developed jointly by the South Platte River Basin Project, Public Health Service, and the Colorado State Department of Public Health.

The long-range goals and objectives of the Project are as follows:

1. Determine the legitimate water uses and locate the sources of pollution having an adverse effect on those uses,

2. Through field investigations determine the physical, chemical, and biological responses of the River to pollution and evaluate the previously located sources of pollution with respect to the conditions in the River.

3. Compute the waste load reductions necessary to obtain desired water quality and recommend water quality control measures needed to effect the desired waste load reductions.

Organization

The South Platte River Basin Project consists of engineering and associated professional and clerical personnel. The Project Headquarters offices are located in downtown Denver and the Laboratory has been established at the Colorado State Department of Public Health, Denver, Colorado. The Project is administratively attached to the Water Supply and Pollution Control program of the Public Health Service, U. S. Department of Health, Education and Welfare, Region VIII, Denver, Colorado

IN

ACKNOWLEDGMENT

Throughout this study, effective coordination was maintained with interested Federal, State, county, municipal and district personnel. The Colorado State Department of Public Health has furnished the Project with past analyses of various treatment plant effluents. In addition, personnel of that agency provided valuable information concerning the design and operation of these plants. The Inter-County Regional Planning Commission was most helpful in providing information regarding the many sanitation districts. Without exception, the officials of the various municipalities and sanitation districts gave freely of their time and knowledge to assist in this study, by furnishing plant operating records, plant laboratory results, and system maps. Plant operators provided assistance in the collection of many samples for the study. The officials of Metropolitan Denver Sewage Disposal District No. 1 supplied extensive information concerning the new Metro facilities. The generous assistance given by the personnel of these agencies is gratefully acknowledged.

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SUMMARY

A study of municipal waste discharges in the Denver Metropolitan area was undertaken by the Project during the period April 1, 1964 - December 31, 1964. Included in this study were 26 sewage treatment plants owned and operated by municipalities, sanitation districts, Federal and State agencies, or industries.

Interviews were held with plant officials in conjunction with a Project sampling program which included analysis of composite and grab samples. Additional operating data were furnished by plant operators and the Colorado State Department of Public Health.

Data for 23 plants were developed to reflect influent and effluent quality, and total loadings discharged to Basin streams. The remaining 3 plants were found to discharge no effluent to the South Platte River or its tributaries. Of the 26 plants, twenty-two receive essentially domestic waste and four receive both industrial waste and domestic waste.

Additional considerations of this investigation included an analysis of effects of the proposed Metropolitan Denver Sewage Disposal District No. 1 (MDSDD#1) treatment facilities and the operation procedures practiced at the various municipal treatment plants in the Metropolitan Denver area.

In close cooperation with the Colorado State Department of Public Health, a proposed pollution abatement schedule was developed which is based on current State Effluent Standards for waste discharges. Recommendations included in the abatement schedule require action to be completed before January 1, 1967, the estimated completion date for the new MDSDD#1 facilities.

CONCLUSIONS

1. The municipal waste facilities in the Metropolitan Denver area at the present time are inadequate. Eighteen of the 23 sewage treatment plants discharging to Basin streams in the study area do not conform to one or more of the State Standards for sewage effluent. Specifically, during the Project study, 18 plants did not conform to State Standards for coliform density, 15 plants did not conform to State Standards for Biochemical Oxygen Demand and 9 plants did not conform to State Standards for suspended organic matter. These conditions can be attributed chiefly to insufficient plant capacity, lack of secondary treatment and poor operational procedures.

2. Significant progress in pollution abatement is now under way for 8 treatment plants affiliated with Metropolitan Denver Sewage Disposal District No. 1. The MDSDD#1 facilities, presently under construction, should provide a substantial reduction in pollutional loads to the Basin streams. The Adolph Coors Company, which operates treatment facilities in Golden, Colorado, is also engaged in a significant pollution abatement program. The construction of additional treatment units scheduled for the summer of 1965, will provide future capacity for this plant.

3. There are 4 entities which operate municipal treatment plants that have initiated corrective action to conform to State Standards for sewage effluent. All of these entities are either in the process of obtaining or have obtained feasibility reports relative to joining the MDSDD#1.

4. Two communities operating municipal treatment plants that now conform to State Standards for sewage effluent with the exception of coliform density require engineering studies to improve plant operation or provide plant expansion in the near future.

5. Three plants which were found in violation of State Standards are not presently committed to a definite course of action.

6. The major portions of Basin streams in the Metropolitan area are grossly polluted primarily as a result of excessive waste loads discharged from municipal treatment plants. Stream conditions in the lower portions of the study area at the time of the Project stream survey presented a picture of severe degradation.

7. Results of current Project programs relating to municipal water supply, farm irrigation, and pollution of ground water will be needed to determine the extent of damages to legitimate water use of Basin streams.

8. The Metropolitan planning concept, as embodied by the MDSDD#1 is a logical and economical solution to the problem of waste treatment in the Denver area.

9. On the basis of present Biochemical Oxygen Demand loads estimated by Project personnel, which are now in excess of projected loads derived by Denver Metro Engineers, it is likely that expansion of secondary treatment facilities at the MDSDD#1 plant will be necessary earlier than the anticipated date of 1980.

RECOMMENDATIONS

The following recommendations have been developed in close coordination with officials of the Colorado State Department of Public Health. These officials are engaged in developing a program of corrective action with the communities involved.

1. The following plants do not provide adequate chlorination because of either lack of facilities or insufficient use of existing facilities. These entities should complete the necessary action to conform with State Effluent Standards for coliform density prior to January 1, 1967.

Thornton	Denver Eastside
North Washington	Aurora Westerly
Baker	South Lakewood
Westminster	Englewood
Arvada	Federal Correctional Institution
Clear Creek Valley	Evergreen
Wheatridge	Littleton
Fruitdale	Adolph Coors Company
Northwest Lakewood	Buckley Air Station

2. Eight plants have joined the MDSDD#1, which will provide the means of correcting their present violation of State Standards with regard to BOD and with the exception of Fruitdale for organic suspended solids. Precautions must be taken to insure that whatever wastes these plants do not convey to MDSDD#1, but continue to discharge to streams, are in compliance with State Standards. The eight plants are listed below:

North Washington	Wheatridge
Baker	Northwest Lakewood
Westminster	Denver Eastside
Arvada	Denver Northside

3. The four plants which have requested feasibility estimates relative to joining MDSDD#1 should complete such action as is necessary by January 1, 1967 to either gain membership in the MDSDD#1 or improve plant performance to insure conformance with State Standards for discharge of BOD, Organic Suspended Solids, Coliform, and Settleable Solids. These are:

Thornton	Aurora (Westerly)
Fruitdale	Clear Creek Valley

4. Three plants not presently engaged in a definite pollution abatement program should complete such action as is necessary by January 1, 1967 to insure conformance with State Standards for effluent discharges. These are:

   South Lakewood
   Federal Correctional Institution
   Evergreen

5. Engineering studies with regard to renovation and expansion of the Littleton Plant and with regard to operational procedures at the Englewood Plant should be completed by January 1, 1966.

6. Although the above recommendations are based on present State Standards for waste discharge, it should be understood that more stringent regulations may be necessary in some instances in order to insure minimum water quality in the receiving stream. These water quality objectives and requirements will be developed in the near future by the joint efforts of the South Platte River Basin Project and the Colorado State Department of Public Health in conjunction with a pollution abatement schedule for water quality control over the entire Basin.

7. An immediate study should be undertaken at the City of Westminster plant to provide interim measures designed to improve the operational procedures during the period of construction of MDSDD#1 plant. The facilities presently available at the Westminster plant appear capable of greater efficiencies in the reduction of BOD and total suspended solids.

8. As a general recommendation, all plants should conform to the "Recommendations for Minimum Personnel, Laboratory Control, and Records for Municipal Waste Treatment Works," as adopted by the 1963 Conference of State Sanitary Engineers. To insure proper plant operation the staff of the State Water Pollution Control Section should be increased to provide the necessary supervision and technical advice.

I. INTRODUCTION

This report presents the results of a field study of municipal wastes in the Metropolitan Denver area during the period April 1, 1964 to December 31, 1964. The objectives of this investigation were to locate the sources of municipal waste discharges, to assess the present treatment facilities provided for those discharges, and in coordination with the Colorado State Department of Public Health, to develop a pollution abatement schedule for such action as is indicated. The current State of Colorado laws governing the discharge of sewage effluents to State waters, upon which the pollution abatement schedule is based, are contained in Appendix A. A survey of municipal wastes in the remainder of the South Platte River Basin will be the subject of a subsequent report.

II. BACKGROUND AND DESCRIPTION

General Description of the Area

The City of Denver, capital of Colorado, is located in the north central portion of the state on the western edge of the Great Plains, approximately 50 miles east of the Continental Divide. The County of Denver has identical boundaries with the City, and both are considered as a single unit in a political as well as a geographical sense. In addition to Denver, the Metropolitan area includes portions of Adams, Arapahoe, Boulder and Jefferson Counties. According to estimates obtained from the State Commerce and Development Division, the population in the City and County of Denver was 525,000 persons as of July 1, 1964, while the Metropolitan area comprised about 1,000,000 persons. The Metropolitan area includes about 700 square miles, which represents 6.7 percent of the area of the entire state. Within these confines about one-half of the total population of the State is located.

The South Platte River, which is 459 miles in length from its point of origin to the junction with the North Platte River in Nebraska, flows diagonally from southwest to northeast through the Metropolitan area. The River enters the Metropolitan area south of Littleton at about river mile 325, and departs in Brighton in the vicinity of river mile 290 (1). The principal tributaries to the South Platte River in the Metropolitan area are Bear Creek (River mile 320.9), Cherry Creek (River mile 312.3), Sand Creek (River mile 306.8) and Clear Creek (River mile 305.5) (1). According to records maintained by the United States Geological Survey (USGS), the annual discharge from Bear Creek, Cherry Creek and Clear Creek is 24,470, 11,800, and 64,220 acre feet respectively (2). Sand Creek contributes an annual flow of about 5,000 acre feet, based on data from the State Engineer's Office.

The valley-fill deposits of the South Platte River Valley in the Metropolitan area consist chiefly of sand and gravel. Large amounts of ground water are present at depths ranging from less than one foot to about 65 feet below the land surface. In this area, the base flow of the mainstem of the South Platte River is supplemented by large amounts of ground-water return flow. Conversely, certain tributaries, notably Sand Creek, contribute a portion of their flow to the shallow aquifer.

Description and Location of Municipal Waste Treatment Facilities

There are about 100 separate entities directly involved in the collection and treatment of sewage in the Metropolitan area. Treatment facilities are provided by 7 sanitary districts, 14 municipalities,

and 5 institutions. The locations and types of treatment for these plants are indicated in Table I, and Figure 1. The major treatment works is the Denver Northside plant, which has an average flow of about 70 million gallons per day (mgd) and serves an estimated 600,000 persons. The remaining 25 sewage treatment plants serve about 354,000 persons. On the basis of these data, municipal wastes for about 95 percent of the population of the Metropolitan area receive treatment at those plants listed in Table I. The present overall reduction of 5-day 20° C Biochemical Oxygen Demand for these municipal treatment plants is about 50 percent. The wastes from the remaining 5 percent of the metropolitan area population, or 46,000 persons are served by septic tanks or similar facilities.

Eighty-one percent of the treated wastes from the Denver Metropolitan area are discharged to the South Platte River. As shown in Figure 1, there are 8 plants along the River which contribute an average discharge of 86.4 mgd. The 8 plants located along Clear Creek discharge 14.4 mgd. Sand Creek and Bear Creek receive wastes from 7 plants which discharge an average of 5.8 mgd. The 3 remaining facilities, largest of which serves 500 persons, do not discharge to Basin streams.

Metropolitan Denver Sewage Disposal District No. 1

In 1960, the Colorado State Legislature passed an act permitting formation of a Metropolitan Sewage Disposal District in any metropolitan area in Colorado. This legislation was sponsored by the Joint Sanitation Commission composed of a number of interested districts and municipalities within the Metropolitan area, and the Inter-County Regional Planning Commission. As a result of this action, the Metropolitan Denver Sewage Disposal District #1 (MDSDD#1) was formed, and provisions were made for an engineering study. The firms of Phillips-Carter-Osborne, Inc., Ken R. White, Inc., and Henningson, Durham, and Richardson, Inc., were retained as consultants under the name of Denver Metro Engineers. The engineers provided the pre-design report in 1961 which proposed the construction of a new metropolitan sewage treatment plant and revisions to the existing Denver Northside Plan (3). Essentially the new plant would provide primary and activated sludge treatment with sludge drying and/or incineration. The present Denver Northside facility would be used for primary treatment only, and its effluent delivered to the proposed MDSDD#1 Metro plant for secondary treatment. All sewage received by the MDSDD#1 plant from areas not served by the Denver Northside plant, would receive both primary and secondary treatment.

In addition to the treatment works, a system of interceptors was proposed which would convey the sewage to the plants. Primarily these collection facilities included interceptors to be constructed

TABLE 1

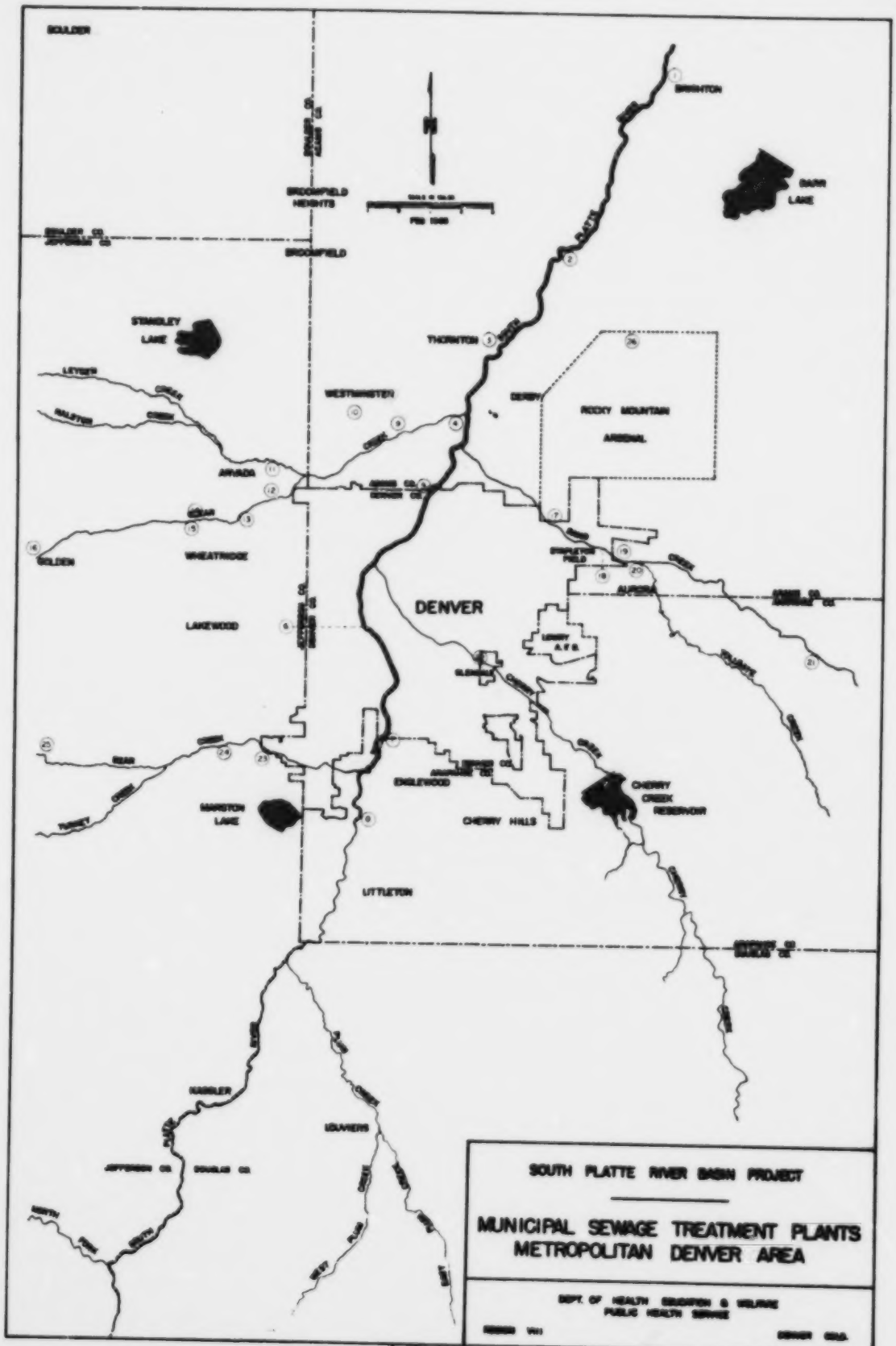
LOCATION OF MUNICIPAL SEWAGE TREATMENT PLANTS IN THE METROPOLITAN AREA

Map Ident. No.	Name of Facility	River Mileage	Type Treatment
1.	City of Brighton	289.5	Secondary
2.	S. Adams Water & San District	301.2	Secondary
3.	City of Thornton	303.5	Secondary
4.	N. Washington Water & San District	305.5	Secondary (c)
5.	Denver - Northside	308.8	Primary
6.	S. Lakewood San District	314.1/2.1 W	Secondary
7.	City of Englewood	319.7	Secondary
8.	City of Littleton	323.5	Secondary
9.	Baker Water & San District	305.5/3.0	Secondary
10.	City of Westminster	305.5/3.6/1.6	Primary
11.	City of Arvada	305.5/6.2/0.3	Secondary
12.	Clear Creek Valley San District	305.5/7.0	Secondary
13.	City of Wheatridge	305.5/7.5	Secondary
14.	Fruitdale San District	305.5/10.0	Primary
15.	N. W. Lakewood San District	305.5/10.2	Primary
16.	City of Golden	305.5/15.5	Secondary
17.	Denver - Eastside	306.8/4.7	Primary
18.	City of Aurora (Westerly)	306.8/5.5/1.1 S	Secondary
19.	City of Aurora (Sand Creek)	306.8/6.8	Secondary
20.	Fitzsimons Hospital	306.8/6.9/0.9	Secondary
21.	Buckley Air Station	306.8/11.9	Secondary
22.	City of Glendale	(a)	Secondary
23.	Colo. State Industrial School for Girls	(a)	Secondary (c)
24.	Federal Correctional Institution	320.9/5.5	Secondary (c)
25.	City of Evergreen	320.9/19.3	Secondary (c)
26.	Rocky Mountain Arsenal	(b)	Secondary (c)

(a) Plant discharge to oxidation pond, no effluent.

(b) Discharges to First Creek, thence to Burlington Canal - Does not enter South Platte River.

(c) No secondary settling facilities available.


BOULDER
BROOMFIELD HEIGHTS
BROOMFIELD
BRIGHTON
BARR LAKE
STANDLEY LAKE
THORNTON
WESTMINSTER
DERBY
ROCKY MOUNTAIN ARSENAL
ARVADA
GOLDEN
WHEATRIDGE
LAKEWOOD
DENVER
AURORA
LOWRY A.F.B.
ENGLEWOOD
CHERRY HILLS
CHERRY CREEK RESERVOIR
HARRISON LAKE
LITTLETON
KASSLER
ISLAVERS
SOUTH PLATTE RIVER BASIN PROJECT
MUNICIPAL SEWAGE TREATMENT PLANTS
METROPOLITAN DENVER AREA
DEPT. OF HEALTH EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
FIGURE 1

4-B

along portions of Bear Creek, Sand Creek, the South Platte River and Clear Creek. The location of the Metropolitan Denver treatment plants affiliated with MDSDD#1, interceptors, and area served are shown in Figure 2.

The pre-design report was accepted and authorization given to prepare final plans. In 1963 the final plans for the first phase of interceptor construction were approved by the Colorado State Department of Public Health (CSDPH), and a contract was awarded. In 1964, the final plans for the MDSDD#1 plant and revisions for the Denver Northside plant were also approved and contracts awarded. Construction of these projects is currently under way and completion of all work is contemplated prior to January 1967.

The MDSDD#1 sewage treatment plant will have an initial capacity of 27 mgd for primary treatment facilities, and 117 mgd for secondary treatment facilities. The revised Denver Northside plant will provide a capacity for primary treatment of 97 mgd with BOD reduction of 35 percent. The initial design for both plants combined will provide treatment for 262,000 pounds of BOD daily with an average removal of 90-95 percent (3).

A total of 46 municipalities and sanitary districts will be served by the MDSDD#1 facilities. Among these agencies there are presently 8 sewage treatment plants in operation, including both Denver plants. Four of these plants now provide primary treatment only. The Denver East Side primary plant will be abandoned and the raw wastes conveyed to the MDSDD#1 facility. The Denver Northside plant will operate in conjunction with the MDSDD#1 facilities. The Northwest Lakewood and Westminster plants may continue operating, but all effluent will be diverted to MDSDD#1 for further treatment. The remaining 4 plants, all of which provide secondary treatment, will have an option of either discharging all wastes, raw or partially treated, into an interceptor, or discharging a portion of effluent to the stream in conformity with State effluent standards and the remainder to the interceptor. It is likely that these treatment plants, with the exception of the Denver facilities, will ultimately be abandoned and all raw wastes conveyed to MDSDD#1. It should be noted that under the agreement between the MDSDD#1 and the member districts and municipalities, no plant can enlarge its present facilities without permission from the Metro District. Based upon the population presently served by agencies committed to membership in MDSDD#1, it is estimated that approximately 75 percent of all persons living within the Metropolitan area will be served by the MDSDD#1.

Present State Laws Governing Waste Discharge

The Colorado General Assembly has enacted legislation contained in Chapter 66 of the Colorado Revised Statutes concerning the power of

the State Department of Public Health to establish the quality of the effluent of sewerage systems and trade wastes that are discharged. This authority has been promulgated in the form of regulations. In addition the statutes prescribe permissible effluent from domestic sewage systems in terms of specific standards. In essence these laws provide that the effluent of domestic sewerage systems shall not contain settleable and suspended organic matter exceeding 0.5 ml/l and 75 mg/l, respectively, shall not exceed 1000 coliform organisms per milliliter when at least 4 samples are collected on 4 consecutive days, and shall not contain dissolved or suspended matter exceeding 50 mg/l in terms of a five-day 20-degree Centigrade Biochemical Oxygen Demand. If the effluent of a sewerage system is discharged into a water course used downstream as a surface source of public domestic water supply, the regulations of the Colorado State Department of Public Health state that the dissolved or suspended matter shall not exceed 30 mg/l in terms of 5-day, 20-degree Centigrade BOD.

That portion of current statutes which pertains to the effluent from sewerage systems is outlined in Appendix A of this report.

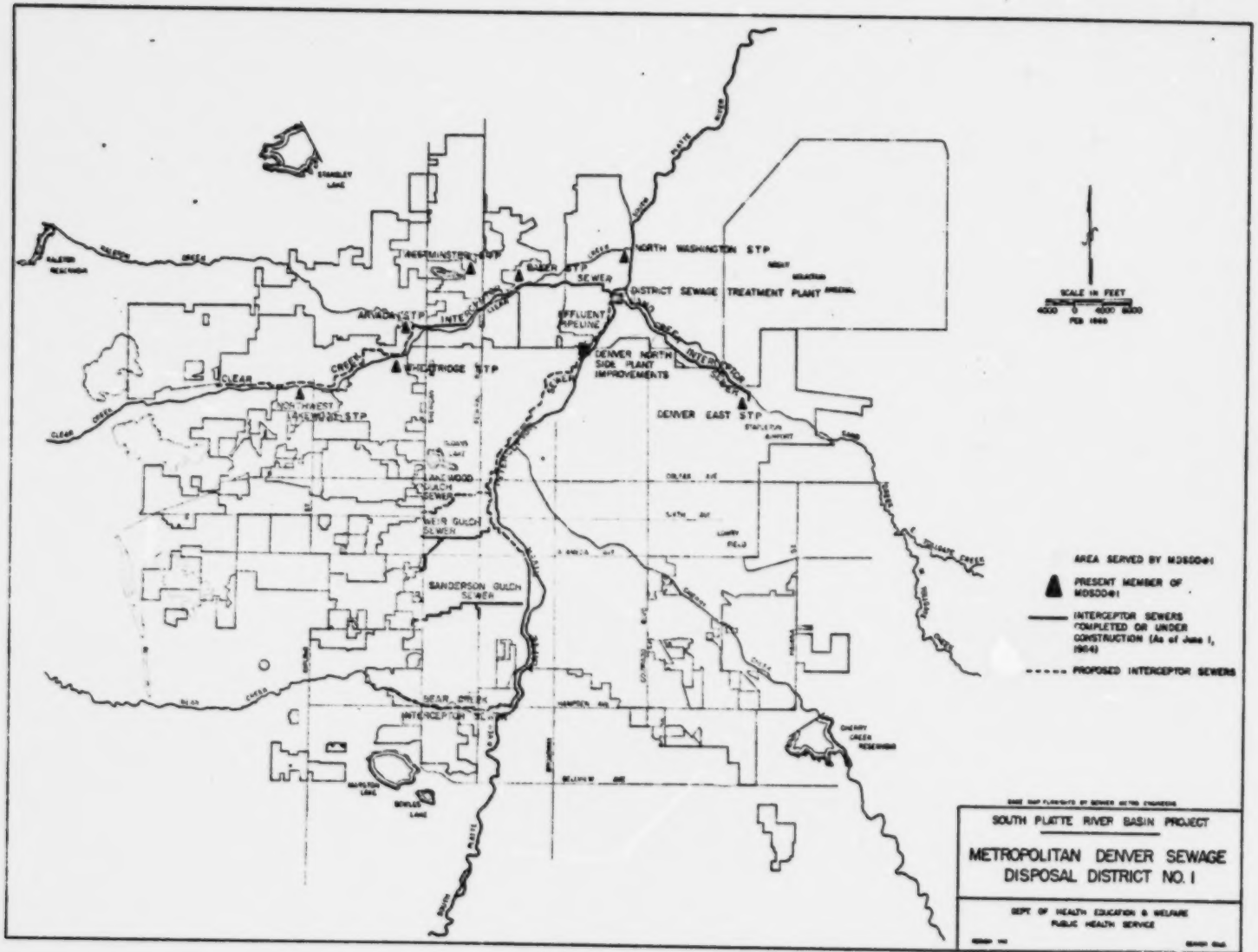

NORTH WASHINGTON STP
DISTRICT SEWAGE TREATMENT PLANT
EFFLUENT PIPELINE
DENVER NORTH SIDE PLANT IMPROVEMENTS
DENVER EAST STP
WESTMINSTER STP
ARVADA STP
WHEATRIDGE STP
SOUTHWEST LAKEWOOD STP
LAKEWOOD GULCH SEWER
WEIR GULCH SEWER
SANDERSON GULCH SEWER
BEAR CREEK INTERCEPTOR SEWER
SCALE IN FEET
AREA SERVED BY MDSDD#1
PRESENT MEMBER OF MDSDD#1
INTERCEPTOR SEWERS COMPLETED OR UNDER CONSTRUCTION (As of June 1, 1964)
PROPOSED INTERCEPTOR SEWERS
SOUTH PLATTE RIVER BASIN PROJECT
METROPOLITAN DENVER SEWAGE DISPOSAL DISTRICT NO. 1
DEPT OF HEALTH EDUCATION & WELFARE
PUBLIC HEALTH SERVICE

FIGURE 2

III. CONDUCT OF THE SURVEY

Interviews and Plant Visits

Project personnel visited each of the sewage treatment plants operating in the Metropolitan Denver area. Interviews were held with institution, municipal and sanitation district officials, including managers, superintendents and operators. The types and condition of treatment units were examined and evaluated at each plant. A check of operating methods and records was made in order to determine variations and amounts of flow, as well as strength of influent and effluent sewage. Together with plant officials, estimates were made concerning the number of persons served by each treatment works. Wherever possible, an estimate of the amount of industrial waste flow to the treatment plant was determined. Such information included the name, type, and location of the industry involved. Particular attention was paid to treatment facilities that appeared obsolete and poorly maintained or operated. Additional factors investigated included provision for bypass of sewage, the laboratory procedures followed, and the general degree of competence and training possessed by the plant operators.

Individual sewage treatment plant reports for each of the facilities in the Metropolitan Denver area are contained in Appendix B, which is published under separate cover.

Procedures

A total of 21 plants was chosen for a waste sampling program which was carried out over a period of nine months, from April through December, 1964. Selection of these plants was based primarily on the lack of sufficient or conclusive performance data. Each plant was sampled for a period of 2-5 days.

Composite samples of the influent and effluent were collected hourly from 8:00 a.m. to 3:00 p.m. each day by the plant operators, and were composited on the basis of flow at the time of collection. In addition, grab samples were collected by Project personnel at various times each day of the sampling period. All samples were analyzed at the Project Laboratory in accordance with "Standard Methods for the Examination of Water and Wastewater" (5). Composite samples were examined for biochemical oxygen demand, total suspended solids, volatile suspended solids, and settleable solids. Grab samples were analyzed for total and fecal coliform, and chlorine residual where applicable. Tabulation of all sampling results is included with the individual plant reports contained in Appendix B.

IV. MUNICIPAL WASTE DISCHARGE

General

The discharges from sewage treatment plants vary in terms of the types of waste received and the degree of treatment provided. Several plants, including Denver Northside, Golden, North Washington, and Clear Creek Valley, receive significant amounts of industrial waste in addition to domestic sewage. Waste loads to the South Platte River and its tributaries from municipal plant effluents have been summarized on the basis of pounds of BOD, pounds of suspended solids and numbers of coliforms discharged daily to the mainstem and the affected tributaries. The latter include Bear Creek, Sand Creek, and Clear Creek.

Of the 23 sewage treatment plants currently operating in the Metropolitan Denver area and discharging to Basin streams, Project waste-sampling activities were conducted at 21 plants to obtain more accurate estimates of pollutional loading to the streams. Sufficient data were available to provide satisfactory estimates for the remaining two plants. In Table II bacteriological loading from 23 plants which discharge to Basin streams is summarized.

Domestic Loading

Twenty-two sewage treatment plants in the Denver Metro area receive essentially domestic wastes. In Tables III and IV estimated daily biochemical oxygen demand and total suspended solids loadings to the streams are shown for 19 of these plants. The remaining three plants do not discharge to Basin streams. BOD data indicated an average of 0.079 pounds per capita for these plants during the eight-hour daytime period. For the 24-hour period, a figure of 0.160 pounds of BOD/cap. was assumed as a reasonable value for plants in the Metro Denver area. An earlier study conducted by the Denver Metro Engineers for six plants included in Table II derived an average value of 0.159 pounds of BOD/cap/day (6). The ratio between the per capita loading values of 0.079 pounds and 0.160 pounds indicates that about 50 percent of the daily BOD load is received during the 8-hour daytime period.

A similar evaluation in the case of TSS indicated a value of 0.081 pounds/cap-8-hour sampling period for these plants. In the 24-hour period, a figure of 0.20 pounds of TSS per capita was assumed as a reasonable value. The ratio between these per capita loadings indicates that about 40 percent of the daily TSS load is received during the 8-hour daytime period.

The percentages of 50 and 40 were applied to the 8-hour loads computed for BOD and TSS respectively and estimates were obtained for loading

TABLE II

MUNICIPAL SEWAGE TREATMENT PLANTS
EFFLUENT BACTERIOLOGICAL LOADING

Map Ident. No.	Name of Plant	Median Total Coliform MPN/100 ml	Median Fecal Coliform MPN/100 ml
1.	City of Brighton	520	48
2.	S. Adams Water & San. District	5,200	1,600
3.	City of Thornton	36,000,000	7,500,000
4.	N. Washington Water & San. District	45,000,000	12,000,000
5.	Denver - Northside	30,000	19,000
6.	S. Lakewood San. District	160,000 (a)	---
7.	City of Englewood	3,700,000 (a)	---
8.	City of Littleton	5,400,000 (a)	---
9.	Baker Water & San. District	9,700,000	5,100,000
10.	City of Westminster	37,000,000	13,000,000
11.	City of Arvada	7,600,000	1,500,000
12.	Clear Creek Valley San. District	8,300,000	3,100,000
13.	City of Wheatridge	1,700,000 (a)	---
14.	Fruitdale San. District	59,000,000 (a)	---
15.	N. W. Lakewood San. District	6,600,000	4,700,000
16.	City of Golden	790,000 (a)	---
17.	Denver - Eastside	140,000	67,000
18.	City of Aurora (Westerly)	4,200,000	1,200,000
19.	City of Aurora (Sand Creek)	18	42
20.	Fitzsimons Hospital	20,000	5,600
21.	Buckley Air Station	79,000	36,000
24.	Federal Correctional Institution	2,600,000 (a)	---
25.	City of Evergreen	3,300,000	460,000

(a) Data furnished by Colorado State Department of Public Health.

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TABLE III

MUNICIPAL SEWAGE TREATMENT PLANT
(Predominantly Domestic Loading)

Map Ident. No.	Name of Plant	Pop. Served	FLOW Total 24 hrs. (M.G.)	FLOW Gal/cap /day (Gal)	FLOW Total 8 hrs (M.G.)	FLOW Ratio 8 hrs/24hr (%)	INFLUENT 8-hr Samp Period (mg/l)	INFLUENT 8-hr Samp Period (lbs)	INFLUENT 8-hr Per (lbs
1	Brighton	7,500	0.65	87	0.237	36.5	220	435	0.
2	S. Adams	16,000	1.5	94	0.564	37.6	300	1,410	0.
3	Thornton	35,000	2.6	74	1.024	39.4	365	3,115	0.
7	Englewood	55,200	4.5	82	1.66	36.8	240	3,325	0.
8	Littleton	23,000	2.6	113	1.00	38.5	235	1,960	0.
9	Baker	17,500	1.5	86	0.645	43.0	265	1,425	0.
10	Westminster	17,500	1.3	74	0.536	41.2	345	1,540	0.
11	Arvada	36,000	3.5	97	1.34	38.3	280	3,130	0.
13	Wheatridge	20,500	1.8	88	0.745	41.4	355	2,205	0.
14	Fruitdale	1,600	0.20	125	0.074	37.7	175	108	0.
15	N.W.Lakewood	21,000	1.9	90	0.766	40.3	265	1,695	0.
17	Denver (East)	18,000	1.4	78	0.594	42.4	340	1,685	0.
18	Aurora (West.)	55,000	3.1	56	1.28	41.3	315	3,365	0.
19	Aurora (Sand)	9,000	0.66	73	0.290	44.0	255	615	0.
20	Fitzsimons	2,900	0.47	160	0.201	42.7	300	505	0.
21	Buckley	400	0.05	125	0.020	39.5	135	25	0.
6	So. Lakewood	6,500	0.55	85	0.200	36.2	270	450	0.
24	F.C.I.	425	0.060	140	0.023	39.4	570	110	0.
25	Evergreen	700	0.065	93	0.026	39.4	260	55	0.
		343,725	29.205	85(a)	11.526	39.4(a)	283(a)	27,208	0.

(a) Weighted Average.

(b) Including effects of sewage bypassed directly to Clear Creek.

NOTE: All BOD values based on 5-day 20° C Analysis.

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TABLE III

MUNICIPAL SEWAGE TREATMENT PLANTS
(Predominantly Domestic Loading)

	INFLUENT BOD					EFFLUENT BOD			
Ratio 8 hrs/24hr	8-hr Samp Period	8-hr Samp Period	8-hr Samp Period	24 hrs. Est.	24 hrs. Est.	8-hr Samp Period	Effi-ciency	24 hrs Est.	P. E. Est.
(%)	(mg/l)	(lbs)	(lbs/cap)	(lbs)	(lbs/cap)	(mg/l)	(%)	(lbs)	
36.5	220	435	0.058	880	0.117	12	95	45	280
37.6	300	1,410	0.088	2,855	0.178	26	91	255	1,600
39.4	365	3,115	0.089	6,310	0.180	205	44	3,535	22,000
36.8	240	3,325	0.060	6,735	0.122	48	80	1,350	8,440
38.5	235	1,960	0.085	3,970	0.172	43	82	715	4,470
43.0	265	1,425	0.081	2,885	0.164	150(b)	43(b)	1,645	10,300
41.2	345	1,540	0.088	3,120	0.178	335	3	3,025	18,900
38.3	280	3,130	0.086	6,340	0.176	210(b)	25(b)	4,755	29,700
41.4	355	2,205	0.107	4,465	0.217	95	73	1,210	7,560
37.7	175	108	0.098	320	0.200	110	37	200	1,250
40.3	265	1,695	0.080	3,430	0.163	215	19	2,780	17,400
42.4	340	1,685	0.093	3,410	0.189	205	40	2,050	12,800
41.3	315	3,365	0.061	6,815	0.123	64	80	1,365	8,530
44.0	255	615	0.068	1,245	0.138	20	92	100	625
42.7	300	505	0.174	800	0.275	27	91	70	440
39.5	135	25	0.062	50	0.125	23	83	9	55
36.2	270	450	0.069	910	0.140	52	81	175	1,100
39.4	570	110	0.258	165	0.388	165	71	50	315
39.4	260	55	0.078	110	0.157	80	69	35	220
39.4(a)	283(a)	27,208	0.079(a)	54,815	0.160(a)	120(a)	57.5(a)	23,369	146,000

to Clear Creek.

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TABLE IV
TOTAL SUSPENDED SOLIDS FOR
MUNICIPAL SEWAGE TREATMENT PLANTS
(Predominantly Domestic Loading)

Map Identification No.	Name of Plant	Pop. Served	FLOW Total 24 hrs. (M.G.)	Gal/cap /day (Gal)	Total 8 hrs (M.G.)	Ratio 8 hrs/24 hr (%)	INFLUENT TO 8-hr Samp. Period (mg/l)	8-hr Samp Period (lbs)
1	Brighton	7,500	0.65	87	0.237	36.5	209	413
2	S. Adams	16,000	1.5	94	0.564	37.6	329	1545
3	Thornton	35,000	2.6	74	1.024	39.4	554	4730
7	Englewood	55,200	4.5	82	1.56	36.8	241	3330
8	Littleton	23,000	2.6	113	1.00	38.5	197	1640
9	Baker	17,500	1.5	86	0.645	43.0	251	1350
10	Westminster	17,500	1.3	74	0.536	41.2	289	1290
11	Arvada	36,000	3.5	97	1.34	38.3	275	3065
13	Wheatridge	20,500	1.8	88	0.745	41.4	288	1790
14	Fruitdale	1,600	0.20	125	0.074	37.7	125	77
15	N. W. Lakewood	21,000	1.9	90	0.766	40.3	360	2325
17	Denver (East)	18,000	1.4	78	0.594	42.4	330	1630
18	Aurora (West.)	55,000	3.1	56	1.28	41.3	270	2880
19	Aurora (Sand)	9,000	0.66	73	0.290	44.0	248	600
20	Fitzsimons	2,900	0.47	160	0.201	42.7	270	452
21	Buckley	400	0.05	125	0.020	39.5	194	32
6	So. Lakewood	6,500	0.55	85	0.200	36.2	243	405
24	F.C.I.	425	0.060	140	0.023	39.4	281	54
25	Evergreen	700	0.065	93	0.026	39.4	404	88
		343,725	29.205	85(a)	11.526	39.4(a)	282(a)	27696

(a) Weighted Average.

(b) Including effects of sewage bypassed directly to Clear Creek

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TABLE IV
TOTAL SUSPENDED SOLIDS FOR
MUNICIPAL SEWAGE TREATMENT PLANTS
(Predominantly Domestic Loading)

		INFLUENT TOTAL SUSPENDED SOLIDS					EFFLUENT TOTAL SUSPENDED SOLIDS		
)	Ratio 8 hrs/24 hr (%)	8-hr Samp. Period (mg/l)	8-hr Samp. Period (lbs)	8-hr Samp. Period (lbs/cap)	24 hrs. Est. (lbs)	24 hrs. Est. (lbs/cap)	8-hr Samp. Period (mg/l)	Effi-ciency (%)	24 hrs. Est. (lbs)
	36.5	209	413	0.055	1020	0.136	34	83.7	170
	37.6	329	1545	0.097	3810	0.238	55	83.3	640
	39.4	554	4730	0.135	11650	0.300	212	61.7	4460
	36.8	241	3330	0.061	8210	0.150	43	82.2	1460
	38.5	197	1640	0.071	4040	0.175	38	80.7	780
	43.0	251	1350	0.077	3330	0.190	105(b)	58.2(b)	1390
	41.2	289	1290	0.074	3180	0.182	196	32.2	2160
	38.3	275	3065	0.086	7580	0.210	209(b)	24.0(b)	5760
	41.4	288	1790	0.087	4420	0.215	64	77.8	980
	37.7	125	77	0.048	190	0.119	75	40.0	110
	40.3	360	2325	0.111	5750	0.274	126	65.0	2010
	42.4	330	1630	0.091	4020	0.223	85	74.2	1040
	41.3	270	2880	0.052	7110	0.131	77	71.5	2030
	44.0	248	600	0.067	1480	0.165	42	83.1	250
	42.7	270	452	0.156	1115	0.384	36	86.7	150
	39.5	194	32	0.081	79	0.197	40	79.4	20
	36.2	243	405	0.062	1000	0.154	76	68.7	310
	39.4	281	54	0.127	133	0.314	80	71.5	40
	39.4	404	88	0.125	217	0.310	86	78.7	50
	39.4(a)	282(a)	27696	0.081(a)	68334	0.200(a)	88(a)	65.2(a)	23810

Clear Creek

to each plant for the 24-hour period. Plant efficiencies in BOD and TSS removal were obtained from average influent and effluent values for these characteristics during the sampling period. These values were applied to the 24-hour loading for these plants and an estimate of pounds of BOD and TSS discharged to the streams was made.

The treatment plants with essentially domestic loading are summarized below:

City of Brighton STP

This low-rate trickling filter plant, which serves 7,500 persons, provides an efficiency of 95 percent for BOD removal, and 84 percent for suspended solids removal according to Project sampling data. The present flow of 0.65 mgd is well below the plant design capacity. Adequate and well operated chlorination facilities are present at this plant. Daily loading to the South Platte River is estimated at 45 pounds of BOD and 170 pounds of suspended solids. Effluent coliform densities averaged 520 MPN per 100 ml for total coliform, and 48 MPN per 100 ml for fecal coliform.

South Adams Water and Sanitation District STP

The South Adams plant, which employs a high-rate trickling filter, operates with efficiencies of 91 percent removal for BOD and 83 percent removal for suspended solids according to Project sampling data. This serves about 16,000 persons, and receives average flows of 1.5 mgd which are well under the present design capacity. Chlorination facilities and operation are considered adequate. Daily loading to the South Platte River is estimated to be 255 pounds of BOD, and 640 pounds of suspended solids. Average effluent coliform values were found to be 520 MPN per 100 ml for total coliform, and 160 MPN per 100 ml for fecal coliform.

City of Thornton STP

The population served by this facility is 35,000 and daily waste flows were found to be 2.6 M.G. The plant, which uses a high-rate trickling filter, is designed for 1.9 mgd. According to Project sampling data the plant efficiency in terms of BOD removal was only 44 percent with 3535 pounds discharged daily, while 4460 pounds of suspended solids were discharged each day indicating a plant efficiency of 62 percent. Both BOD and suspended solids values in the plant effluent were consistently above State Standards. In addition, the lack of adequate chlorination facilities was reflected in the effluent coliform densities which averaged 36,000,000 MPN per 100 ml for total coliform, and 7,500,000 MPN per 100 ml for fecal coliform.

City of Englewood STP

This municipality operates two plants, both using the high-rate trickling filter process. These plants, which are designed for a combined capacity of 8 MGD, utilize a single outfall to discharge effluent to the South Platte River. The average daily flow received at these plants amounts to 4.5 mgd, and an estimated 55,000 persons are served. Project sampling data indicated plant efficiencies of 80 and 82 percent for BOD and suspended solids removal, respectively. Daily loading to the river was estimated at 1350 pounds of BOD and 1460 pounds of suspended solids.

City of Littleton STP

This plant serves about 23,000 persons, and has an average daily flow of 2.6 mgd. The design capacity of this trickling filter operation is rated at 2.8 mgd. There are no chlorination facilities and the coliform densities are considerably greater than State Standards. Project sampling data indicated plant efficiencies of 82 percent for BOD removal, and 81 percent for suspended solids removal. Daily loading to the river was estimated at 715 pounds of BOD, and 780 pounds of suspended solids. A comparison of present average daily flow and rated capacity indicates that planning for expansion of plant facilities should be initiated immediately.

Baker Water and Sanitation District STP

The District plant, which employs the high-rate trickling filter process, serves about 17,500 persons and has an average daily flow of 1.5 mgd. This facility is rated at a capacity of 1 mgd, and plant effluent values are consistently greater than State Standards. In addition, a portion of raw sewage is bypassed during periods of peak flow. There are no chlorination facilities provided for this plant. Project sampling data indicated plant efficiencies, including that portion which was bypassed, were 43 percent for BOD removal and 58 percent for suspended solids removal. Daily loading to Clear Creek was estimated to be 1645 pounds of BOD, and 1390 pounds of suspended solids.

City of Westminster STP

This plant only provides primary treatment, since the trickling filter units are presently being bypassed. The average daily flow, on the basis of 17,500 persons served, is estimated at 1.3 mgd. The rated plant capacity is also 1.3 mgd. Although chlorination facilities are provided at this facility they were not in use. Project sampling data indicated daily loading to Clear Creek of 3025 pounds of BOD and 2160 pounds of suspended solids. Plant efficiencies showed virtually no BOD removal, and 32 percent removal of suspended solids. It appears that, although the plant is affiliated with MDSDD#1 for future disposal of sewage, an immediate effort to improve plant efficiency should be made.

City of Arvada STP

This sewage treatment plant serves about 36,000 persons and is greatly overloaded. The average daily flow of 3.5 mgd is well in excess of the rated plant capacity of 0.75 mgd. Consequently, about 2.4 mgd of raw sewage is bypassed to Clear Creek without treatment. No chlorination facilities are provided at this plant. Project sampling data indicated plant efficiencies, including the effects of that portion which is bypassed, were 25 percent for BOD removal, and 24 percent for suspended solids removal. Total daily loading was estimated at 4755 pounds of BOD and 5760 pounds of suspended solids.

Wheatridge Sanitation District STP

This plant employs the standard trickling filter process and serves 20,500 persons. It receives a flow of 1.8 mgd which equals the plant design capacity. According to Project sampling data, the plant achieves 73 percent BOD removal, discharging 1200 pounds to Clear Creek daily; 980 pounds of suspended solids are also discharged daily, from a total of 4420 pounds received, resulting in 78 percent removal. Chlorination facilities are provided at this plant.

Fruitdale Sanitation District STP

The District operates a primary plant serving about 1600 persons. Although the facilities are adequate as far as capacity is concerned, the lack of sufficient means of treatment results in violation of State Standards. Project sampling data indicated plant efficiencies of 37 percent for BOD removal and 40 percent for suspended solids removal. Daily loading to Clear Creek was estimated at 200 pounds of BOD and 110 pounds of suspended solids. No chlorination facilities are provided at this plant.

Northwest Lakewood Sanitation District STP

This plant, which serves 21,000 persons, provides primary treatment and receives flows equal to its design capacity of 1.9 mgd. No chlorination facilities are present. Project sampling data showed plant efficiencies of 19 percent for removal of BOD and 65 percent for removal of suspended solids. It was estimated that Clear Creek receives daily loads of 2780 pounds of BOD and 2000 pounds of suspended solids. Bacteriological loading averaged 6,600,000 MPN per 100 ml of total coliform, and 4,700,000 MPN per 100 ml of fecal coliform.

City and County of Denver Eastside STP

This plant is the smallest of two facilities operated by Denver. It serves 18,000 persons and has an average flow of 1.4 mgd. The plant operates primary facilities including chlorination equipment. Project

sampling data indicated the plant effluent in excess of State Standards. Plant efficiency for BOD reduction was 40 percent, and 74 percent for suspended solids reduction. Daily loading to Sand Creek was estimated at 2050 pounds of BOD and 1040 pounds of solids. Poor chlorination practices resulted in bacteriological loading of 140,000 MPN per 100 ml for total coliform, and 67,000 MPN per 100 ml for fecal coliform.

City of Aurora - Westerly Creek STP

This trickling filter plant is the largest of two facilities operated by Aurora. The plant design capacity of 2.5 mgd has been exceeded, as the 55,000 persons served contribute over 3 mgd average flow. Consequently the effluent to Sand Creek is in violation of State Standards. Plant efficiencies were 80 percent reduction for BOD, and 72 percent reduction for suspended solids. Project sampling data indicated an estimated 1350 pounds of BOD, and 2030 pounds of suspended solids were discharged daily into the stream. Bacteriological loading averaged 4,200,000 MPN per 100 ml for total coliform, and 1,200,000 MPN per 100 ml for fecal coliform, indicating unsatisfactory operation of existing chlorination facilities.

City of Aurora - Sand Creek STP

This extended aeration type plant is the smaller of two facilities operated by Aurora. About 9,000 persons are served, and contribute an average flow of 0.7 mgd. This plant has a rated capacity for 1.0 mgd. In addition, the plant is well-operated and is in conformance with State Standards. Project sampling data indicated daily loading to Sand Creek was 100 pounds of BOD, resulting in a plant efficiency of 92 percent, and 250 pounds of suspended solids, providing a plant efficiency of 83 percent. Bacteriological loading to the streams averaged 180 MPN per 100 ml for total coliform, and 4.2 MPN per 100 ml for fecal coliform, indicating satisfactory chlorination operation.

Fitzsimons Army Hospital STP

This high-rate trickling filter plant is operated by the Department of the Army and, following chlorination and detention in a polishing pond, the effluent is discharged to Sand Creek. The plant is well-operated and is in conformity with State Standards. Based on plant operating records for the past two years, the efficiency of BOD reduction averaged 91 percent, while the efficiency of suspended solids removal averaged 87 percent. Daily loading to Sand Creek was estimated at 70 pounds of BOD and 20 pounds of suspended solids. Project sampling data indicated bacteriological loading averaged 20,000 MPN per 100 ml for total coliform and 5600 MPN per 100 ml for fecal coliform.

Buckley Air Station STP

This trickling filter plant was designed to handle a capacity of 1.5 mgd during World War II, however, a substantial reduction of base personnel has resulted in a present average flow of 0.05 mgd. Project sampling data indicate plant efficiencies of 83 percent for BOD removal, and 79 percent for suspended solids reduction. Daily loading to Tollgate Creek averages 9 pounds of BOD and 20 pounds of suspended solids. No chlorination facilities are provided at this plant.

South Lakewood Sanitation District STP

The District operates an extended aeration plant which receives 0.6 mgd of sewage, which is the plant's capacity, from about 6,500 persons. Project sampling data indicated plant efficiencies of 81 percent for BOD removal, and 69 percent for suspended solids removal. Daily loading to the South Platte River was estimated to be 175 pounds of BOD and 310 pounds of suspended solids. This plant was found in violation of State Standards from the standpoint of BOD, suspended solids and bacteriological effluent discharge.

Federal Correctional Institution STP

This plant at a Federal prison is operated by the Department of Justice and discharges sewage effluent to Bear Creek. The facilities include an Imhoff tank and trickling filter, however, no secondary settling or chlorination is provided. Project sampling data estimated plant efficiency for BOD removal at 71 percent, resulting in daily loading of 50 pounds. Plant efficiency for suspended solids reduction was estimated to be 72 percent, resulting in daily loading to the stream of 40 pounds. The plant effluent was in violation of State Standards regarding BOD, suspended solids and coliform.

Town of Evergreen STP

This trickling filter plant provides treatment for sewage from about 700 persons during the winter, and several times that figure during the summer. Project sampling data indicated plant efficiencies during June, of 69 percent for BOD reduction, and 79 percent for suspended solids reduction. Daily loading to Bear Creek was estimated to be 35 pounds of BOD and 50 pounds of suspended solids. Although chlorination facilities were provided at this plant, they have never been used. The plant effluent was found to be in violation of State Standards for BOD, suspended solids, settleable solids and coliform.

Domestic and Industrial Loading

In Tables V and VI estimated BOD and TSS loadings are shown for four sewage treatment plants which receive significant amounts of industrial

wastes. A large majority of industries that discharge their wastes to these sewage treatment plants operates for a 5-day period each week. For this reason the data are based on a 5-day week, since this period represents the most severe conditions in terms of industrial contributions. The data regarding industrial loading for these plants were obtained from treatment plant records, engineering studies and industrial plant surveys. The Adolph Coors Company Brewery operates throughout the entire week; therefore, the data for Golden is presented in terms of a 7-day week.

Inasmuch as the factors involved in the determination of pollutional loading vary widely, these treatment plants are described below.

City of Golden Sewage Treatment Plant

About 8,000 persons in the City of Golden are served under contractual agreement by this sewage treatment plant, which is owned and operated by the Adolph Coors Company. The sewers in Golden are predominantly combined, and data from the plant indicates the domestic BOD loading to be 0.19 pounds per capita per day. The treatment plant, which provides secondary treatment prior to discharge into Clear Creek, also processes industrial waste from the Adolph Coors Brewery. According to treatment plant records the average daily loading is shown below:

	# BOD	# Suspended Solids
Brewery	14,400	2,700
Domestic	1,500	1,400
Total	15,900	4,100

This company has been successful in reducing wastes, particularly solids, within the manufacturing process. The treatment provided consists essentially of primary settling, mechanical aeration, secondary settling and removal of dewatered sludge to a company-owned landfill. A well-equipped laboratory provides an excellent record of performance. These plant records indicate that the sewage treatment plant has provided a high degree of both BOD and solids removal during the calendar year 1964. Based upon a series of 24-hour composites obtained and analyzed by plant personnel during late 1963 and early 1964, the effluent quality averaged 640 pounds of BOD and 475 pounds of suspended solids for a plant efficiency of 96 and 89 percent. The Coors Company are commended for their concern with water pollution and the measures that they have taken to provide successful treatment for a highly organic waste.

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TABLE V

SUMMARY OF MUNICIPAL TREATMENT PLANTS WITH SIGNIFI

Location	Population Served	Est. Daily Domestic Flow M.G.	Est. Daily Industrial Flow M.G.	Est. Total Daily Flow M.G.	Domestic Per Capita Flow Gal/Cap/Day	Domestic per Capita BOD Loading Lb/cap/Day	Est. Daily Domestic BOD Loading Lbs	Est. Daily Domestic BOD Loadi
Clear Creek Valley District	7,000	1.19	0.30(a)	1.49(a)	170(b)	0.16	1,120	4,0
Denver Northside	600,000	51.00	21.53(a)	72.53(a)	85	0.16	96,000	85,0
Golden	8,000	1.20	1.50	2.70	150(c)	0.19(c)	1,500	14,4
North Washington District	12,000	1.15	0.35(a)	1.50(a)	96	0.16	1,920	9,8

(a) Industrial flows and loading based on a 5-day week.
(b) High per capita flows likely due to ground water infiltration into sewers.
(c) Domestic sewers are combined, causing higher per capita flows and BOD loading.
(d) Obtained from Project sampling program, based on 8-hour daytime composites.
(e) Obtained from STP records, based on 24-hour composites.

TABLE V

MUNICIPAL TREATMENT PLANTS WITH SIGNIFICANT INDUSTRIAL WASTES - BOD

rial Flow st. M.G.	Total Daily Flow	Domestic Per Capita Flow	Domestic per Capita BOD Loading	Est. Daily Domestic BOD Loading	Est. Daily Industrial BOD Loading	Est. Total BOD Loading	Influent BOD	Effluent BOD	Present Plant Efficiency	Est. Total Daily BOD Loading to Stream
	Gal/Cap/ Day	Lb/cap/ Day	Lbs	Lbs	Lbs	Lbs	Mg/l	Mg/l	%	Lbs
1.49(a)	170(b)	0.16	1,120	4,000(a)	5,120(a)		865(d)	285(d)	67	1,690(a)
2.53(a)	85	0.16	96,000	85,000(a)	181,000(a)		299(e)	174(e)	42	105,000(a)
2.70	150(c)	0.19(c)	1,500	14,400	15,900		750(e)	30(e)	96	636
1.50(a)	96	0.16	1,920	9,840(a)	11,760(a)		1,150(d)	435(d)	62	4,460(a)

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TABLE VI

SUMMARY OF MUNICIPAL TREATMENT PLANTS WITH SI

Location	Population Served	Est. Daily Domestic Flow M.G.	Est. Daily Industrial Flow M.G.	Est. Total Daily Flow M.G.	Domestic Per Capita Flow Gal/Cap/Day	Domestic Per Capita TSS Loading Lb/Cap/Day	Est. Dail Do Lbs
Clear Creek Valley District	7,000	1.19	0.30	1.49(a)	170(b)	0.200	1,400
Denver Northside	600,000	51.00	21.53	72.53(a)	85	0.200	120,000
Golden	8,000	1.20	1.50	2.70	150(c)	0.200	1,600
North Washington	12,000	1.15	0.35	1.50(a)	96	0.200	2,400

(a) Industrial flows and loading based on a 5-day week.
(b) High per capita flows likely due to ground water infiltration into sewers.
(c) Domestic sewers combined, causing higher per capita flows.
(d) Obtained from Project sampling program, based on 8-hour daytime composites.
(e) Obtained from STP records, based on 24-hour composites.

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TABLE VI

MUNICIPAL TREATMENT PLANTS WITH SIGNIFICANT INDUSTRIAL WASTES - TSS

	Est. Total Daily Flow M.G.	Domestic Per Capita Flow Gal/Cap/Day	Domestic Per Capita TSS Loading Lb/Cap/Day	Est. Daily Domestic TSS Loading Lbs	Est. Daily Industrial TSS Loading Lbs	Est. Total TSS Loading Lbs	Influent TSS Mg/l	Effluent TSS Mg/l	Present Plant Efficiency %	Est. Total Daily Loading to Stream Lbs
	1.49(a)	170(b)	0.200	1,400	2,000(a)	3,400(a)	738(d)	117(d)	84	545(a)
	72.53(a)	85	0.200	120,000	108,000(a)	228,000(a)	378(e)	96(e)	75	57,000(a)
	2.70	150(c)	0.200	1,600	2,700	4,300	182(e)	20(e)	89	475
	1.50(a)	96	0.200	2,400	11,480(a)	13,880(a)	1,280(d)	360(d)	72	3,900(a)

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North Washington Water and Sanitation District

This District operates a sewage treatment plant which serves a population of about 12,000 persons and receives industrial wastes from four meat packing plants. These industries include National Foods, which slaughters and provides packing and rendering for an average of 400 cattle daily; Litvak Meat Company, which slaughters and provides rendering for an average of 250 cattle daily; Rio Grande Packing Company, which slaughters an average of 145 cattle daily; and Altberger Company, which slaughters an average of 25 cattle daily. These plants, with the exception of the Altberger facility, provide some degree of in-plant pre-treatment in order to remove paunch manure, blood, grease, and a portion of solid waste prior to the final discharge into the District's sanitary sewers. The Altberger plant disposes of all process waste in the District sewerage facilities.

Factors of 12 pounds of BOD and 14 pounds of TSS per animal were used (7)(8)(9) to estimate the pounds of BOD and TSS discharged to the District plant from industrial sources. The 11,760 pounds of BOD received daily at the District plant, including domestic wastes, is somewhat less than the total of 12,625 pounds indicated by the Denver Metro Engineers in 1962 (6). Project sampling data indicated a plant efficiency of 62 percent for BOD removal and 72 percent for TSS removal. The daily loading to the stream is estimated to be 4,460 pounds of BOD and 3,900 pounds of TSS.

Clear Creek Valley Water and Sanitation District

This District's sewage treatment plant receives domestic wastes from about 7,000 persons and industrial waste from the Sigman Meat Company, Inc. The packinghouse operation includes beef and slaughtered hogs. The hog carcasses are delivered to the plant for processing of smoked and cured meats. The blood and renderable products are collected daily and sold to the Denver Rendering Company.

In December 1962 the consulting firm of Kirkham, Michael and Associates prepared a report for the Sigman Company concerning process wastes. At that time the following data were obtained for the plant effluent to the District plant for a 5-day week: 3,570 pounds of BOD per day, 1,690 pounds of TSS per day, and 1,590 pounds of volatile suspended solids per day. Present loading from this source is estimated at 4,000 pounds of BOD and 2,000 pounds of TSS daily. Combined domestic and industrial loading to the District plant is estimated to be 5,100 pounds of BOD and 3,400 pounds of TSS daily. Project sampling data indicated a plant efficiency of 67 percent for BOD removal and 84 percent for TSS removal. The daily loading to the stream is estimated to be 1,700 pounds of BOD and 550 pounds of TSS.

Denver Northside Sewage Treatment Plant

This facility is the largest treatment works in the Metropolitan area. Although originally designed as a secondary facility, the plant now provides only primary treatment consisting of pre-aeration basins, primary settling chambers, sludge digesters, and sludge beds. The original magnetite filter basins, which were intended to provide secondary treatment, have been converted for use as chlorination detention chambers. In 1964, it is estimated that 600,000 persons were served by this plant. Based upon data obtained from plant records for the period December 1, 1963-November 30, 1964, the average flow into the plant was 70.05 mgd. Daily 24-hour composite samples collected and analyzed by plant personnel indicated an average influent BOD of 278 mg/l and an average effluent BOD of 151 mg/l.

On the basis of these data, the plant received an average loading of 163,000 pounds of BOD daily. Based on the average figure of 85 gallons per capita per day derived from the Project survey of plants in the Metropolitan Denver area, and 0.160 pounds of BOD per capita, the domestic contribution to this plant on an average daily basis would be 51 mgd and 96,000 pounds of BOD per day. The remainder of the total flow and loading, which is estimated as 19 mg. and 67,000 pounds, can be attributed to industrial sources. However, since the majority of the industrial contribution is received at the plant during a 5-day period, the daily flow and loading data obtained from the plant has been examined on a weekday (Monday through Friday) basis.

During the period December 1, 1963 to November 30, 1964, there was a total of 261 weekdays. The average flow was 72.53 mgd during this time. The influent BOD averaged 299 mg/l and the effluent BOD averaged 174 mg/l. From this information, the average daily loading received in the plant during the 5-day week was 181,000 pounds of BOD. Thus, the industrial flow averaged 21.5 mgd and 85,000 pounds of BOD per day during this 5-day period. The influent TSS averaged 378 mg/l and the effluent TSS averaged 96 mg/l. The average daily load to the plant during the 5-day week was 228,000 pounds of TSS. Based on plant data, daily loading to the river was estimated at 105,000 pounds of BOD, and 57,000 pounds of suspended solids. Project sampling data indicated that the mean coliform density of the chlorinated effluent was less than 100,000 organisms per ml.

Due to insufficient digestor capacity, partially-digested sludge and sludge supernatant have been discharged directly to the South Platte River in the past. Project personnel were informed that this practice was discontinued in August, 1964 and that the supernatant is now being recycled to the influent lines for additional treatment.

Loading to the South Platte River and Tributaries

Table VII contains a summary of flow data, BOD, TSS and coliform loading from municipal sewage treatment plants to the South Platte River and each of the principal tributaries in the Metropolitan area. Where significant industrial wastes are present, the data, with the exception of the Golden sewage treatment plant, is presented in terms of a 5-day week.

The total daily loadings to Basin streams in the Metropolitan area are estimated to be 135,000 pounds of BOD and 86,000 pounds of TSS. The major source of pollution, accounting for nearly 78 percent of the total BOD load and 66 percent of the total TSS load, is the Denver Northside plant which presently has primary treatment facilities. Sewage treatment plants serving Arvada, Aurora (Westerly), Baker District, Clear Creek District, Denver Eastside, North Washington District, Northwest Lakewood District, Thornton, and Westminster together contribute 18 percent of the total BOD load and 27 percent of the total TSS load. The average daily flow at each of these plants exceeds the present plant capacity and four of these facilities are providing only primary treatment.

TABLE VII

SUMMARY OF MUNICIPAL SEWAGE TREATMENT PLANT LOADING TO STREAMS

Stream	Plant Location	River Mile	Estimated Average Daily Flow MGD	BOD Discharged to Stream Lbs/day	Total Susp. Sol. Discharged to Stream Lbs/day	Total Coliform MPN/100 ml
Bear Creek		320.9				
	Evergreen	320.9/19.3	0.065	35	50	3,300,000
	Federal Correctional Institution	320.9/5.5	0.060	50	40	1,600,000
South Platte River	Littleton	323.5	2.60	715	780	5,400,000
	Englewood	319.7	4.50	1,350	1,460	3,700,000
	S. Lakewood	314.1	0.55	175	310	160,000
	Denver - Northside	308.8	72.53(a)	105,000(a)	57,000(a)	30,000
	North Washington	305.5	1.50(a)	4,460(a)	3,900(a)	45,000,000
	Thornton	303.5	2.60	3,535	4,460	36,000,000
	South Adams	301.2	1.50	255	640	5,200
	Brighton	289.5	0.65	45	170	520
Sand Creek		306.8				
	Buckley Air Station	306.8/11.9	0.05	9	20	
	Fitzsimons Hospital	306.8/6.8	0.47	70	150	5,600
	Aurora - Sand Creek	306.8/6.8	0.66	100	250	18
	Aurora - Westerly	306.8/5.5	3.10	1,365	2,030	4,200,000
	Denver - Eastside	306.8/4.7	1.40	2,050	1,040	140,000
Clear Creek		305.5				
	Golden	305.5/15.5	2.70	636	450	790,000
	Northwest Lakewood	305.5/10.2	1.90	2,780	2,010	6,600,000
	Fruitdale	305.5/10.0	0.20	200	110	9,700,000
	Wheatridge	305.5/7.3	1.80	1,210	980	1,900,000
	Clear Creek Valley	305.5/7.0	1.50(a)	1,690(a)	545(a)	8,300,000
	Arvada	305.5/6.2	3.50	4,755	5,760	7,600,000
	Westminster	305.5/3.6	1.30	3,025	2,160	37,000,000
	Baker	305.5/3.0	1.50	1,645	1,390	9,700,000

(a) Based on a 5-day week. (b) Not including bypass.

V. DISCUSSION

Future Operation of Metropolitan Denver Sewage Disposal District No. 1

The Metropolitan Denver Sewage Disposal District No. 1 waste treatment plant, which is scheduled to commence operation prior to January 1, 1967 should provide substantial pollution abatement for Basin streams in the Metro Denver area. In addition, these facilities will offer the advantages of a centralized location and an economical means of providing adequate sewage treatment. The design of the District plant has sufficient flexibility to allow for expansion of both primary and secondary treatment facilities in several stages. Denver Metro Engineers estimate that expansion of the District plant will be required in 1981 for primary treatment facilities and in 1982 for the secondary treatment facilities (11). If the Clear Creek secondary treatment plants are abandoned, these expansion dates are estimated to be 1974 for primary treatment and 1980 for secondary treatment.

The present Denver Northside treatment plant has been expanded and is currently undergoing renovation. According to design criteria published by MDSDD#1 in February 1964, the revised Denver Northside plant will be expected to receive a BOD loading of 207,000 pounds daily with a removal of 35 percent or 72,500 pounds of BOD (12). The remaining 134,500 pounds of BOD will receive secondary treatment at the Metro District plant. The Metro District primary treatment works are designed to remove 35 percent of 63,500 pounds of BOD from wastes received daily from the Clear Creek and Sand Creek interceptors. The discharge from these primary treatment units will be routed to the secondary treatment facilities at the District plant. According to the design criteria mentioned above, the Metro District secondary treatment works are capable of handling 166,350 pounds of BOD daily. The following table is presented to clarify the BOD loadings described above.

	Primary Treatment		Secondary Treatment		
	In (lbs)	Out (lbs)	In (lbs)	Out (lbs)	
Denver Northside Plant	207,000	134,500	--	--	
MDSDD#1 Plant	63,000	41,300	175,800	27,000	(90% removal)
Totals	270,000	175,800	175,800	27,000	

Data obtained by Project personnel from plant records at the Denver Northside works for the period December 1963 to November 1964 indicated the average daily influent loading on a 5-day week basis was 181,000

pounds of BOD. These data also revealed that during the months of July and October 1963, 215,000 and 226,000 pounds respectively of BOD was the average daily contribution to this plant in terms of a 5-day week. These values are already in excess of the daily BOD loading of 207,000 pounds previously indicated as a design factor for this plant. It is likely that the recirculation of sludge supernatant to the plant influent line affected the loading for October; however, this condition did not exist in July. It is also significant that total BOD loading to this plant on a 5-day week basis has increased from about 140,000 pounds per day in 1960 according to Metro Denver Engineers (3) to an estimated 181,000 pounds per day in 1964. Additional loading to the Northside plant will be realized by diversion to the Denver sanitary sewers of industrial and commercial wastes now discharging directly to the streams.

On the basis of the conditions outlined above and the possibility that the Clear Creek secondary treatment plants will cease to operate within a few years, it is likely that expansion of secondary treatment facilities at the Metro District plant will be necessary earlier than the anticipated date of 1980.

Operation of Municipal Waste Treatment Plants

Three components of sound operation for any waste treatment plant are 1) personnel, 2) laboratory control, and 3) records. Sufficient personnel with skills commensurate to the size and complexity of the plant are required to obtain the degree of treatment provided by the plant design and to maintain and protect the community's investment in the physical plant. In order to measure the degree of treatment being obtained and to locate existing or impending operational troubles, adequate laboratory control must be exercised. The third operating component, keeping records, is necessary for proof of performance and for use in planning and justifying future plant needs and expansions.

"Recommendations for Minimum Personnel, Laboratory Control, and Records for Municipal Waste Treatment Works," adopted in 1963 by the Conference of State Sanitary Engineers and published in cooperation with the Department of Health, Education, and Welfare, outlines by plant capacity, the minimum requirements for each component in order to provide adequate operation control (13).

During the Project study of municipal waste treatment plants in the Metropolitan Denver area, each plant was evaluated with respect to these factors. Only four plants were found to be in substantial conformance with these Minimum Recommendations. These plants are Fitzsimons, Adolph Coors (Golden), Aurora (Westerly), and Denver Northside. The remaining 19 plants provide some degree of laboratory control, minimum personnel requirements and provisions for record

keeping; however, considerable improvement can be obtained for relatively little additional expense. It is proposed that the provisions of "Recommendations for Minimum Personnel, Laboratory Control and Records" (13) be adopted for all municipal sewage treatment plants in Colorado.

Pollution Abatement

The schedule contained in Table VIII is recommended to provide pollution abatement for municipal sewage treatment plants in the Metropolitan Denver area based upon existing State Law and regulations. In determining whether or not there is a present need for pollution abatement at a specific plant, an examination of several factors is required. Such considerations include: 1) the waste load reductions necessary to provide the desired water quality in the receiving water, and 2) the performance of the treatment plant in terms of operational efficiency. These factors have been examined for each plant in terms of the existing State regulations and laws governing sewage effluent discharges. That portion of current statutes which pertains to the effluent from sewerage systems is outlined in Appendix A of this report.

It is not intended however to define premissible loading from a municipal waste treatment plant discharge to a receiving stream solely upon that which is now permitted under present State Standards. The capacity of the stream to absorb wastes from a single municipal waste plant effluent must be considered in the light of other waste discharges both above and below the plant and the pattern of flow and diversions associated with the receiving water. In the final analysis each waste discharge permitted in the Basin will have to conform to criteria considered necessary to provide water quality in the streams according to the maximum beneficial use. At this time such water quality criteria has not been established and therefore the present State Standards have been employed only as a general guide.

Those municipalities and districts which are presently affiliated with MDSDD#1 are considered to be committed to an effective course of pollution abatement. These include Arvada, Baker District, Denver, North Washington District, Northwest Lakewood District, Westminster and Wheatridge. The facilities for MDSDD#1 are presently under construction and current estimates indicate operation of the treatment works will commence prior to January 1, 1967. The Adolph Coors Company, which operates the sewage treatment plant in Golden is committed to an effective program for pollution abatement. This industry's wastes are in conformity with State waste effluent standards, except during periods of peak flows. Expansion of plant facilities is planned during 1965. The completion date proposed for those plants at which major revisions or improvements have been recommended is also January 1, 1967.

TABLE VIII

POLLUTION ABATEMENT SCHEDULE

Plant Name	Design capacity (mgd)	Avg. Flow (mgd)	Effluent Quality BOD (Mg/l)	VSS (Mg/l)	Coliform Density (MPN/100 ml)	Recommendations	Suggested Abatement Schedule
Member Plants of MDSDD#1							
Baker W & S District	1.0	1.5	150	85	9.7×10^6	Divert sewage to MDSDD#1 and provide adequate treatment including chlorination for any sewage discharged to Clear Creek.	Jan. 1967
City of Westminster	1.25	1.3	335	155	3.7×10^7	Arrange for an engineering study to evaluate operation procedures and improve plant efficiency; and,	Immediately
						Divert sewage to MDSDD#1 and provide adequate treatment including chlorination for any sewage discharged to Clear Creek.	Jan. 1967
City of Arvada	0.75	3.5	210	205	7.6×10^6(e)	Divert sewage to MDSDD#1 and provide adequate treatment including chlorination for any sewage discharged to Clear Creek.	Jan. 1967
Wheatridge	1.75	1.80	95	56	1.7×10^6(a)	Divert sewage to MDSDD#1 and provide adequate treatment including chlorination for any sewage discharged to Clear Creek.	Jan. 1967
Northwest Lakewood Sanitation District	1.8	1.9	215	106	6.6×10^6	Divert sewage to MDSDD#1	Jan. 1967

Table VIII (Continued)
Pollution Abatement Schedule

Plant Name	Design capacity (mgd)	Avg. Flow (mgd)	Effluent Quality BOD (mg/l)	VSS (Mg/l)	Coliform Density (MPN/100 ml)	Recommendations	Suggested Abatement Schedule
Member Plants of MDSDD#1							
North Washington W & S District	1.0	1.4	435	309	4.5×10^7	Divert sewage to MDSDD#1 and provide adequate treatment including chlorination for any sewage discharged to Clear Creek.	Jan. 1967
City of Denver (Eastside Plant)	2.0	1.5	205	85	1.4×10^5	Divert sewage to MDSDD#1	Jan. 1967
City of Denver (Northside Plant)	85	70.5(b)	151(b)	66(b)	3.0×10^4	Divert effluent to MDSDD#1	Jan. 1967
Plants not presently Members of MDSDD#1:							
City of Brighton	2.0	0.65	12	24	5.2×10^2	NONE	---
South Adams County Sanitation District	2.5	1.5	26	43	5.2×10^3	NONE	---
City of Thornton	1.9	2.6	205	175	3.6×10^7	Revise and expand plant facilities to provide adequate treatment, including chlorination for present and future loadings (c)	Jan. 1967
Clear Creek Valley Sanitation District	0.85	1.4	285	100	8.3×10^6	Revise and expand plant facilities to provide adequate treatment including chlorination for present and future loadings (c)	Jan. 1967

Table VIII (Continued)
Pollution Abatement Schedule

Plant Name	Design Capacity (mgd)	Avg. Flow (mgd)	Effluent Quality BOD (mg/l)	Effluent Quality VSS (mg/l)	Effluent Quality Coliform Density (MPN/100 ml)	Recommendations	Suggested Abatement Schedule
Plants not presently Members of MDSDD#1:							
Fruitdale Sanitation District	2400 (d) persons	0.2 (winter) 1.0 (summer)	110	60	5.9×10^7(a)	Revise and expand plant facilities to provide adequate treatment including chlorination for present and future loadings (c)	Jan. 1967
Adolph Coors Co.	4.5	2.7	30(b)	35(b)	7.9×10^5(a)	Complete planned expansion and provide adequate chlorination.	Jan. 1967
City of Aurora (Westerly)	3.1	2.5	64	61	4.2×10^6	Complete planned diversion of flow to new (Sand Creek) plant and provide adequate chlorination (c)	Jan. 1967
City of Aurora (Sand Creek)	1.0	0.66	20	32	$<1 \times 8 \times 10^1$	Complete planned expansion of plant facilities to process flow diverted from Westerly plant (c)	Jan. 1967
Fitzsimons Army Hospital	.90	0.47	27(b)	36(b)	2.0×10^4	NONE	---
Buckley Air Station	1.5	0.05	23	27	7.9×10^4	Provide adequate chlorination facilities.	Jan. 1967
South Lakewood Sanitation District	0.6	0.6	52	64	1.6×10^5(a)	Complete engineering study and planned expansions to include adequate chlorination.	Jan. 1967
City of Englewood	8.0	4.5	48	39	3.7×10^6(a)	Complete engineering study to determine present and future needs including adequate chlorination.	Jan. 1966

Table VIII (Continued)
Pollution Abatement Schedule

Plant Name	Design Capacity (mgd)	Avg. Flow (mgd)	Effluent Quality BOD (mg/l)	Effluent Quality VSS (mg/l)	Effluent Quality Coliform Density (MPN/100 ml)	Recommendations	Suggested Abatement Schedule
Plants not presently Members of MDSDD#1:							
City of Littleton	2.75	2.6	43	33	5.4×10^6(a)	Complete planned engineering study to determine present and future needs including adequate chlorination.	Jan. 1966
Federal Correctional Institution	0.6	0.06	165	55	2.6×10^6(a)	Discharge all wastes to the Lakehurst Sanitation District.	Jan. 1967
Town of Evergreen	0.25	0.065	80	80	3.3×10^6	Revise or expand plant facilities to provide adequate treatment including adequate chlorination for present and future loadings.	Jan. 1967

(a) Data furnished by Colorado State Department of Public Health.
(b) Data furnished by plant operator.
(c) Has requested feasibility estimate from MDSDD#1.
(d) Limited by digestor capacity.
(e) Not including bypassed sewage.

It has been recommended that steps be undertaken by January 1, 1967 to provide adequate chlorination facilities in those plants which will continue to discharge wastewater to Basin streams after construction of the MDSDD#1 treatment facilities has been completed.

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APPENDIX A

COLORADO STATE DEPARTMENT OF PUBLIC HEALTH
DIVISION OF SANITATION
Water and Sewage Laws (Health Department)

The following items are taken from the laws governing the Colorado State Department of Public Health. These items consist of pertinent extracts contained in Chapter 66 of the Colorado Revised Statutes, 1953, together with the amendments as enacted by the General Assembly in 1955 and 1959. These particular items deal with the minimum standards allowable for water supplies used for human consumption and domestic sewage and trade wastes. They also deal with the standards and hearing procedures for the control of domestic sewage.

66-1-7. POWERS AND DUTIES OF THE STATE DEPARTMENT OF PUBLIC HEALTH
The state department of public health shall have and exercise, in addition to all other powers and duties imposed upon it by law, the following powers and duties:

. . . . .

(5) To establish and enforce minimum general sanitary standards as to the quality of water supplied to the public and as to the quality of the effluent of sewerage systems and trade wastes discharged upon the land or into the surface or ground waters, and as to the quality of fertilizer derived from excreta of human beings or from the sludge of sewage disposal plants; and to advise with municipalities, utilities, institutions, organizations and individuals, concerning the methods or processes believed best suited to provide the protection or purification of water and the treatment of sewage and trade wastes to meet such minimum general sanitary standards;

. . . . .

(8) To establish, maintain and approve chemical, bacteriological and biological laboratories, and to conduct such laboratory investigations and examinations as it may deem necessary or proper for the protection of the public health;

(9) To make, approve and establish standards for diagnostic tests by chemical, bacteriological and biological laboratories, and to require such laboratories to conform thereto; and to prepare, distribute and require the completion of forms or certificates with respect thereto;

. . . . .

(18) (Subsection revised by Amendment enacted by the General Assembly, 1955)

The phrase "minimum general sanitary standards" as used in this section shall mean the minimum standards reasonably consistent with protection of the public health, and in the case of minimum general sanitary standards as to the quality of water supplied to the public, the same shall in no event be less than the drinking water standards of the United States Public Health Service. The word "standards" as used in this section shall mean standards reasonably designed to promote and protect the public health.

(19) (Subsection added by the General Assembly, 1959)

(a) To enforce the public policy of the state of Colorado with reference to the pollution of waters of the state by human excreta as herein expressed, it is hereby declared that the health, safety, and welfare of the inhabitants of the state of Colorado require that the streams, lakes, and other waters of the state be kept free of pollution by human wastes, and it is therefore declared to be the public policy of this state that no discharge which contains human excreta shall be permitted to flow in the streams, lakes, or other waters of this state, unless such discharge shall comply with all

standards of the state board of health adopted pursuant to law; and in addition thereto the following standards shall apply:

(b) The number of coliform count in such discharge shall not average more than one thousand per milliliter, such average being based upon a total of not less than four samples taken at the rate of at least one sample per day over a period of four consecutive days.

(c) Minimum standards for effluent from sewerage systems shall be not more than five-tenths milliliter per liter for settleable organic matter, shall be not more than seventy-five parts per million by weight for suspended organic matter, and shall be not more than fifty parts per million for the combined suspended and dissolved organic matter when measured in terms of five day twenty degree, centigrade, biochemical oxygen demand test.

(d) The methods of examination employed to determine compliance with any one of the above standards shall be those set forth in Standard Methods for the Examination of Water Sewage and Industrial Wastes, Tenth Edition, prepared and published jointly by the American Public Health Association, The Federation of Sewage and Industrial Wastes Associations, and the American Water Works Association, New York, 1955.

(e) In addition to all other powers, duties and means of enforcement of the above stated standards, it shall be the duty of the department of public health to investigate and determine the facts with reference to the discharge or disposition of sewage or any other matter containing, or having had as a component part thereof, human excreta in any stream, lake or body of water within the state, upon its own initiative or upon the filing with such department of a verified petition as herein provided. Said petition may be filed with the department by the governing body of any municipality, or any county, or any county or district health department, or any state agency or any twenty-five residents of any county complaining of pollution resulting from any one source which pollution exists in the county of residence of the petitioners, alleging that such discharge or other disposition in such stream, lake or other body of water is in violation of any law or of any rule or regulation of the state board of health, and identifying the person, or persons, instrumentalities or agencies responsible for such discharge or other disposition.

(f) Such study, investigation or survey may include engineering studies and bacteriological, biological and chemical analyses of the effluent or other matter so discharged or disposed of in said waters to the extent that they may be necessary to determine the facts and to establish ways and means of eliminating such violations of law, rules or regulations as may be found to exist. The director shall, within a reasonable time, make tentative findings in writing which shall set forth the matters investigated and shall specify the violations, if any, found to have occurred, and the extent and degree thereof, together with a tentative determination of the person or persons, instrumentalities or agencies responsible therefor, and also the methods of eliminating the source or cause of the violation. If no violation is found the director shall forthwith order the proceedings dismissed, in which the case the petitioners, if any, may have the director's findings and order of dismissal reviewed as provided in section 66-1-13. If one or more violations are found, said tentative findings shall fix a time and place for a hearing before the state board of health which shall be not less

than thirty days after issuance and service as herein provided of said tentative findings. A copy of such tentative findings shall be served by registered or certified mail upon each person, agency or instrumentality alleged by said petition or determined by said findings to be responsible therefor and upon at least one of the initiators of the petition, if any; or service may be made in the same manner as is provided by the rules of civil procedure for personal service of process. The hearing by the board shall be held as is provided by subsection (8) of section 66-1-8.

(g) Plans, specifications, and other related data pertaining to the proposed construction of any and all publicly or privately owned community water or sewage treatment facilities, not including industrial plants, shall be submitted to the state department of public health for review of sanitary engineering features prior to the construction of such facilities.

(h) The Colorado state department of public health is hereby delegated the responsibility of establishing and maintaining a quality testing program on the waters of the state. Such testing program shall be for the purpose of determining adequacy of abatement measures, developing programs for abatement, and ascertaining changes, natural and otherwise, in water quality.

(i) The examination for water quality shall include such physical, chemical, biological, and radiological or other tests as may be necessary in order to be useful in determining the effects upon water quality employed for possible recreational, industrial, agricultural, fish and wildlife, and municipal uses.

(j) The Colorado state department of public health, in the exercise of these duties and powers shall advise, consult, and cooperate with the cities, sewer districts, intercounty regional planning agencies, other agencies of the state, the federal government, and other states and interstate agencies, and industries, in furtherance of the purposes of this section.

66-1-8. POWERS AND DUTIES OF THE STATE BOARD OF HEALTH
In addition to all other powers and duties conferred and imposed upon the state board of health by the provisions of this article, the board shall have and exercise the following specific powers and duties:

. . . . .

(5) To hold hearings, administer oaths, subpoena witnesses and take testimony in all matters relating to the exercise and performance of the powers and duties vested in or imposed upon the state board of health.

. . . . .

(8) (Subsection added by the General Assembly, 1955)

Upon the issuance of a tentative finding as provided by section 66-1-7 (19), the state board of health shall, on the day set for hearing by said finding or any day to which the same may be continued, proceed to hear the matter. The board shall afford a fair and full opportunity to all parties in interest to be heard in person or by counsel as to the correctness of the tentative findings of the director, and said board shall then make its findings. If the board finds that the tentative findings of the director with respect to any violation of law or of the rules and regulations of the board is substantially correct, and if the person, persons, agencies or instrumentalities responsible for such violations have been

before the board, then the board shall direct such person, persons, agencies or instrumentalities to abate the violations. If, however, it appears that the person, persons, agencies or instrumentalities responsible for the violations have not been before the board, then the hearing shall be continued until such time as jurisdiction over such parties is acquired by service upon them in the manner provided in section 66-1-7(19) of a copy of the director's tentative findings and of the board's determination that the presence of such person, persons, agencies or instrumentalities is necessary to a complete determination of the procedure. Every such person, persons, agencies or instrumentalities shall be given full and fair opportunity to be heard, and the hearing to which the proceeding shall be continued shall be de novo, unless the new party or parties, having been properly served shall fail to appear.

A copy of the decision of the board shall be promptly served upon each party in interest by registered mail and shall set forth a reasonable time as determined by the board for the abatement of any violations found to exist, which reasonable time may at the discretion of the board be extended from time to time for good cause shown by the party responsible for such abatement.

All findings of violations, and orders for abatement thereof must be made by a vote of a majority of the members of the state board of health. All such decisions of the board shall be subject to judicial review as provided in section 66-1-13, and all orders of the board issued hereunder may be enforced as any other standard rule, regulations or order of the board.

66-1-13. JUDICIAL REVIEW OF DECISIONS. Any person aggrieved by a decision of the board or the director and affected thereby shall be entitled to judicial review by filing in the district court of the county of his residence, or of the city and county of Denver, within ninety days after the public announcement of the decision, and appropriate action requesting such review. The court may make any interested person a party to the action. The review shall be conducted by the court without a jury and shall be confined to the record, if a complete record is presented, except that in cases of alleged irregularities in the record or in the procedure before the board or the division of administration, testimony may be taken in the court. The court may affirm the decision or may reverse or modify it if the substantial rights of the appellant have been prejudiced as a result of the findings and decisions of the board being:

(1) Contrary to constitutional rights or privileges; or

(2) In excess of the statutory authority or jurisdiction of the board or the director, or affected by any error of law; or

(3) Made or promulgated upon unlawful procedure; or

(4) Unsupported by substantial evidence in view of the entire record as submitted; or

(5) Arbitrary or capricious.

Any party may have a review of the final judgment or decision of the district court by writ of error to the supreme court.

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